

A brief discussion of methods and principles that can serve as a guide for studying the present status of air pollution sampling instruments and their application to field problems.

Sampling Instruments For Air Pollution Surveys

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THE SELECTION and use of suitable sampling instruments for appraising atmospheric contamination in industrial areas is becoming an increasingly important problem. In recent years, the attention of the public has been focused on pollution of the atmosphere outside the factory, and incidents, such as that at Donora, Pa., and the oil refinery tragedy at Poza Rica, Mexico, have helped to highlight the need for cleaner city and industrial area environments.

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Because the atmosphere has not been recognized by the public as a carrier of disease, clean air has not received the same attention as a safe drinking water supply. Man can apparently tolerate a significant amount of airborne pollution without interference with his daily activities. In fact, in some instances he deliberately pollutes his own inspired air without immediate significant consequences—through his own smoking.

In the past 2 decades, industrial hygienists have made great strides in developing sampling devices and survey equipment for inplant air contamination. Fundamentally, those instruments can be applied to many atmospheric pollution problems, but there are certain basic differences which should be pointed out. Ordinarily, industrial hygiene sampling as encountered in factory work involves concentrations of contaminants within or near the so-called maximum allowable or hygienic standard concentrations for 8-hour exposure. These concentrations may vary anywhere from 10 to 1,000 or more times the values found in outdoor contaminations. In many cases, odors are a cause for public complaint, and concentrations of these may be as little as one-millionth of the permissible values used for occupational disease control.

Another feature of industrial hygiene sampling besides the higher concentrations which may be encountered is the fact that experienced personnel are usually available for sampling and analysis. Except for a few agencies, this does not obtain for atmospheric pollution problems. The many small city or town groups which are often involved have limited means of obtaining objective data.

This brings us to the fundamental need for simple and direct methods of evaluation for the usual cases of air pollution. Special types of contaminants will require special treatment and expert advice, but certain widely present, common contaminants are subject to measurement by uncomplicated apparatus and procedures.

Nature of Airborne Contaminants

The materials emitted into the atmosphere vary widely in composition, concentration, and size. They come from numerous sources, such as from the combustion of solid, liquid, or gaseous fuels, from industrial processes, from the burning of rubbish, from transportation vehicles, and from many other sources. These airborne contaminants may be created by man or by nature.

In physical nature, these pollutants may be gases or solid or liquid particulate matter. Chemically, they may be inorganic or organic, metallic or nonmetallic, and they may be elements, compounds, or mixtures. They may range in concentration from conditions which obscure sunlight to barely perceptible odors. They vary in size from microscopic to submicroscopic and change in concentration with altitude and distance from various sources. Some pollution is present in the atmosphere in most locations around the globe. Certain contaminants from fires, explosions, or chemical reactions have traveled thousands of miles.

Sampling Instruments

The problem of devising sampling instruments for such a wide variety of materials complicates the control of air pollution to some extent. The problem is ordinarily broken down into handling these contaminants on the basis of their physical state according to whether

they are (*a*) gases and vapors, or (*b*) particulate matter—dusts, fumes, smokes, mists. Complete but somewhat arbitrary descriptions of these classifications are given in many sources. The ones most widely used are those described by the author (*1*).

Whereas smokes may be solid or liquid, and mists are usually liquid, dusts and fumes are usually solids. These two types of particulate matter range in size from molecules to 50 microns or more for dusts. Fumes and smokes exist in the smallest size ranges for particulate matter, usually less than 0.5 micron.

The method of sampling is influenced by the time available and the concentration of the aerosol. Ordinarily, samples for atmospheric pollution studies are divided into three categories:

1. High concentrations (sampling from stacks or process effluents). Gases are measured in percentages by volume; particulate matter in grams per cubic meter.

2. Intermediate concentrations (sampling in the wake of stacks or close to industrial plants). Gases are measured in parts per million; particulate matter in milligrams per cubic meter.

3. Low concentrations (sampling in polluted city atmosphere or at considerable distances from industrial operations). Gases are measured in hundredths of parts per million, or in parts per 100,000,000; particulate matter in micrograms per cubic meter.

The selection of instruments for these conditions is dependent on the range encountered, which is not always easily determined.

Gases and vapors in high concentrations can be collected instantaneously in evacuated flasks or continuously in absorption vessels. With sensitive chemical methods, the use of instantaneous samples may be extended to intermediate concentrations. Continuous absorption is usually preferred since it gives integrated evaluations. Low concentrations require continuous absorption methods and sensitive chemical procedures.

Particulate materials may require one or more of several types of evaluation: gravimetric, surface area, stain, or particle enumeration. In addition, it may be necessary to measure the size of the individual particles.

The collection of particulate samples depends on one or more of the following principles: (a) sedimentation, (b) visual or photometric absorption, (c) inertial and centrifugal force, (d) impingement (impaction and jet condensation), (e) filtration, (f) washing or scrubbing, (g) thermal precipitation or electrostatic precipitation.

Typical methods for particle size evaluation depend on microscopic examination of a sample from the collected material in the instruments incorporating the above principles. Another approach is to use an instrument which separates particulate matter as sampled; so far, only cascading with a series of different-sized impingement nozzles or centrifugal action (conifuge) has been successfully applied for this purpose.

At the present time, there are many instruments available for sampling which incorporate one or more of the above principles. A brief survey of each type is given in the accompanying table, adapted from the author's article (2) and from the Handbook on Air Cleaning (3), which has since been expanded considerably in the Air Pollution Abatement Manual, chapter 6, by Magill (4).

Methods and Their Limitations

Basically, all of the methods proposed and used in air pollution sampling surveys have some inherent limitations. The general philosophy with regard to sampling has been to place more emphasis on particulate collection devices than on gas-sampling units. Most gases can be determined with known efficiencies and with limitations only as to the size of sample necessary for analysis. Certain gases, such as ozone and oxides of nitrogen, require special techniques for collection and analysis, but others can be collected and analyzed without difficulty.

The particulate sampling problem has been handled principally by considering the nuisance aspects of pollution as the paramount aspects. With this approach, settled dust is a major item and is determined by settling chambers (dust- or soot-fall cans). Unfortunately, no standard size chamber has been used, and different techniques have been applied such

as using water or other liquids to prevent blow-out, various types of shields and grids, wind-direction louvers, and wind-controlled openings.

Staining or soiling is another major nuisance aspect of air pollution. This has been measured by a variety of devices utilizing either impingement on a white surface or filtration through a filter paper. A number of samplers of both manual and automatic types have been developed, and all appraisal has been on an arbitrary stain or scale. The British Fuels Research Station has been sampling for many years and has used a photometric comparison scale with weight equivalents for the type of atmospheres encountered in English cities. This approach, as well as the other methods used by the fuels research station, is covered completely in the Leicester report (5).

From the Leicester report, it is apparent that the British felt that the best methods which could be used were not in existence at the start of their investigation, hence they compromised on procedures and devices which could be widely used and which would yield pertinent data. The methods used in their study, and now applied on a countrywide basis in England, Scotland, Wales, and North Ireland, employ a standard settling jar and a filter stain procedure combined with an SO₂ determination by absorption in a standard iodine solution. In addition, monthly H₂SO₄ evaluations using an exposed lead peroxide procedure have given them an index of corrosive effects of the acid in the atmosphere.

At the present time, several hundred stations in the British Isles make monthly reports of soluble and insoluble deposit (total solids) from the settling jar, and of SO₃ concentrations as acid in milligrams per day per 100 square centimeters of exposed lead peroxide. Sulfur dioxide in parts per 100,000,000 parts of air, and smoke values as filter stain in milligrams per 100 cubic meters are also reported.

Since a major portion of the pollution in Great Britain results from combustion of solid fuels, that nation's approach to the sampling problem is not complicated by special situations and contaminants such as exist in Los Angeles and certain other locations in the United States. Nevertheless, the devices the British have standardized can yield information of importance in

determining the background of American cities and towns.

None of the British methods or those used by investigators in this country can be considered as absolute. The problem of sampling has so many inherent difficulties and so much variability owing to industrial process and meteorologic conditions that it is doubtful whether absolute methods are essential. But whether a particular device selected can give reproducible and consistent results for a known atmosphere is the important factor to determine.

From this brief discussion of methods, it is apparent that simple, direct procedures are the ones which should be applied first to give an estimate of the overall background. These can be modified and improved to provide for special situations if necessary. For example, in sampling suspended solids or particulates a wide variety of filter media are available, and precipitation methods can be used for even smaller sizes, although they may require more elaborate equipment. If filtration procedures are employed, it is possible to obtain stain, weight, and chemical analyses without difficulty. It can be expected that even more efficient media can be developed if necessary.

Research in Progress

Much of the research in progress on sampling instruments has been performed in conjunction with various air pollution surveys. The most recent examples are those relating to the Los Angeles smog problem, conducted by the Stanford Research Institute and the Los Angeles Air Pollution Control Board, and the Detroit-Windsor air pollution survey, which is a joint United States-Canadian project involving the Public Health Service and the Canadian Government.

In Los Angeles, the Stanford group is working on oxidants and direct measurement of hydrocarbons in the air by infrared absorption spectrophotometers. Some work along these lines is also conducted by the Los Angeles County Air Pollution Control Board in its activities.

At Detroit and Windsor, Ont., surveys of neighborhood pollution by gas analysis for sulfur dioxide, fallout, and suspended material

determinations have been made on a large scale, but most of the instrumentation has utilized modifications of existing devices and newer recorder developments. Some instrument development suitable for survey work has been done by the New York City office of the Atomic Energy Commission, and by the Armour Research Foundation, the University of Illinois, Harvard University, the University of Washington, and by the Robert A. Taft Sanitary Engineering Center and the Occupational Health Program of the Public Health Service. Other institutions have also made considerable investigations into aerosol technology and applications of present sampling instruments to certain problems.

Aside from developing or applying methods for specific problems, very little effort has been devoted to approaching the problem on a national basis. The work of the recently established American Society for Testing Materials D-22 (methods of atmospheric sampling and analysis) Committee may contribute materially to the problem by the development of tentative standards for various sampling and analytical methods.

Needed Areas of Research

Actually, the research to be done on sampling instruments is of such nature that extensive laboratory or field work is not necessary at present. The application of standard meteorologic precipitation gauges for determining soluble and insoluble deposits may require some study, and it is hoped that this can be done. The selection of suitable suspended-matter samplers also needs some study as to rate, media, and the type of analysis to be applied. Work on gas sampling is of secondary importance, since suitable sulfur and acid gas recorders such as the Thomas autometer and the Titrilog are available, and simple gas-absorption instruments such as those used at Leicester are also readily obtained or assembled. The basic research data to be obtained are essentially field records of particulate fall and suspended matter on a national and geographic basis, coordinated and correlated with existing meteorologic information for the sampling period. In areas such as Los Angeles gas sampling may be of

Comparison of various devices commonly

Instrument	Type of contaminant	Application	Sample volume
Method: sedimentation			
Settling pan ¹	Particulate	General atmospheres and stacks (low concentrations)	440 ml.
Sedimentation cell ²	do.	do.	50 ml., small
Method: visual or photometric absorption			
Ringelmann chart ³	Particulate	Stacks and high concentrations.	
Tyndallometer ⁴	do.	do.	
Photoelectric densitometer ⁵	do.	do.	
Method: inertial and centrifugal force			
Labyrinth ⁶	Particulate	Stacks and process effluents	Large
Midget cyclone ⁷	do.	do.	do.
Aerotec tube design 2 ⁸	do.	do.	do.
Method: impingement (impaction and jet condensation)			
Owens ⁹	Particulate	General atmospheres and after gas-cleaning devices.	50-100 ml., small
Konimeter ¹⁰	do.	do.	2.5-5 ml., small
Bausch and Lomb ¹¹	do.	do.	0.001 cu. ft.
Impinger ¹²	Particulate and gaseous.	do.	Medium
Cascade impactor ¹³	Particulate	do.	Small

used for stack, effluent, and aerosol sampling

Sampling rate	Particle size range	Remarks
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Method: sedimentation

Unknown-----	High-low, 10-mesh- variable.	Not usually used in stack sampling because size of aliquot is not representative. Efficiency of settling pan unknown; of sedimentation cell, 100 percent. Difficulty in Green cell is one of microscopic measurement; also requires long settling time for small sizes. Instruments require little skill for operation, analytic skill for quantitation (methods: weight, count, or chemical analysis).
Instantaneous-----	10-mesh-0.2 μ -----	

Method: visual or photometric absorption

Variable-----	10-0.1 μ -----	Subject to many limitations cited in the reference. ³ Direct reading only. Requires some skill in operation, little in quantitation (method: comparison with standards). Direct reading only. Has largely been replaced by direct reading photometric units. Requires some skill in operation and quantitation (method: visual recording). Devices of this type have been improved, and several designs have been developed. The latest include electronic methods of counting particles but only in dilute suspensions. Direct reading only. Requires some skill in operation and quantitation (method: photometric density).
do-----	do-----	
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Method: inertial and centrifugal force

Variable-----	10-mesh-1 μ -----	Labyrinth device separates material in proportion to terminal velocity. Efficiency of all inertial or centrifugal separating devices varies with sampling rate and particle size. Efficiency of labyrinth device unknown. Efficiencies of the others are on a weight basis: cyclone device, 98 percent; tube, 94; but on a count basis, efficiency values obtained are all less than 50 percent. These instruments require some skill in operation and analytic skill in quantitation (methods: weight, count, or chemical analysis).
25-50 cu. ft./min-----	10-mesh-5 μ -----	
35 c.f.m-----	do-----	

Method: impingement (impaction and jet condensation)

Instantaneous-----	10-0.2 μ -----	Adapted to low concentrations only. Particle sizing may be done directly on slide. 99 percent efficient. Requires some skill in operation, considerable skill in quantitation (method: count).
do-----	do-----	Adapted to low concentrations only. 99 percent efficient. Requires some skill in operation, considerable skill in quantitation (method: count).
do-----	do-----	Modified Owens with simplified darkfield counting microscope integral with instrument. 99 percent efficient. Requires some skill in operation and quantitation (method: count).
1 c.f.m-----	25-0.5 μ -----	Can be used for both gases and particulate material. 93-96 percent efficient, but if operated at sonic nozzle velocity, efficiency for particles as small as 0.1 μ reportedly 100 percent. Can only be used for readily soluble gases. Requires considerable skill in operation and quantitation (methods: count, weight, or chemical analysis).
17 liters/min-----	100-0.2 μ -----	Provides rapid means of fractionating aerosol by terminal velocity. Not well adapted to high concentrations if slides are to be counted. 95 percent efficient; for absolute efficiency, use sonic velocity in last stage. Requires considerable skill in operation and quantitation (methods: count or chemical analysis).

Comparison of various devices commonly

Instrument	Type of contaminant	Application	Sample volume
Method: filtration			
Paper thimble ¹⁴	Particulate	Stack and general atmospheres	
Paper disks or pleated paper ¹⁵	do	do	Small, medium, or large.
Cotton, wool, or asbestos bags ¹⁶	do	do	Large
Glass fibers, cloth, or alundum thimbles. ¹⁷	do	do	Small, medium, or large.
Wire screen or gauge ¹⁸	do	do	Large
Volatile or soluble crystals ¹⁹	do	do	Small, medium, or large.
Millipore or molecular filter ²⁰	do	do	Small
All-glass web filter, 1106B or 935B ²¹	do	do	Small, medium, or large.

Method: washing or scrubbing

Simple bubbling devices ²²	Gaseous and particulate.	Stack and general atmospheres	Small
Sintered glass absorbers ²²	do	do	do
Wetted packed towers (bead columns, etc.) ²²	do	do	Medium

used for stack, effluent, and aerosol sampling—Continued

Sampling rate	Particle size range	Remarks
Method: filtration		
1-3 c.f.m.-----	10-mesh-0.2 μ -----	Not adapted to high temperatures or moist atmospheres. 95 percent efficient. Requires some skill in operation and quantitation (methods: weight, stain, count, or chemical analysis).
1-3 c.f.m. 40-60 c.f.m.	-----do-----	Can measure quantitatively by discoloration in low concentrations. "Tar Camera," American Society of Heating and Ventilating Engineers, Bureau of Standards use modifications. 99 percent efficient. Requires some skill in operation, analytic skill in quantitation (methods: weight, stain, count, or chemical analysis).
10-50 c.f.m.-----	10-mesh-1 μ -----	Life is limited; handling of sample for particle sizing is difficult. 99 percent efficient. Requires some skill in operation, analytic skill in quantitation (methods: weight, stain, count, or chemical analysis). Primarily adapted to weight determination.
1-3 c.f.m.-----	-----do-----	Alundum filters possess high flow resistance. 90-95 percent efficient; glass cloth and fibers may have low efficiency if fibers not fine or well packed. Glass filters (sintered or fibers) appear to give good results. Requires some skill in operation and analytic skill in quantitation (methods: weight, stain, count, or chemical analysis).
1-10 c.f.m.-----	10-mesh-10 μ -----	Material for screen is 400-mesh cloth (expensive). Efficiency variable, 50-70 percent. Not satisfactory for fine materials until bed has accumulated. Requires some skill in operation and in quantitation (methods: weight, stain, count, or chemical analysis).
1-30 c.f.m.-----	10-mesh-0.2 μ -----	Not adapted to high temperatures. 35-90 percent efficient. Industrial Hygiene Foundation has modified method for high volume sampling. Requires some skill in operation, analytic skill in quantitation (methods: weight, stain, count, or chemical analysis).
1-3 c.f.m.-----	10-mesh-0.1 μ -----	Not adapted to high temperatures or many organic solvents. Can be made transparent with immersion oil for direct observation. More than 99.9 percent efficient. Requires some skill in operation, analytic skill in quantitation (methods: weight, stain, count, or chemical analysis).
1-50 c.f.m.-----	-----do-----	Will withstand temperatures to 1000° F. More than 99.9 percent efficient. Requires some skill in operation, analytic skill in quantitation (methods: weight, stain, count, or chemical analysis).

Method: washing or scrubbing

0.5-1 c.f.m.-----	10-mesh-10 μ -----	90-95 percent efficient; efficiency low for particulate material unless very coarse; efficiency for gases is dependent on their solubility and rate of reaction. Requires some skill in operation, analytic skill in quantitation (methods: chemical analysis or weight).
0.1-0.5 c.f.m.-----	10-0.2 μ -----	95 percent efficient; highest efficiency devices for gases; for particulate material rate must be kept low. Porosity of sintered glass affects efficiency since separation is due to filtration and scrubbing. Requires some skill in operation, analytic skill in quantitation (methods: chemical analysis or weight).
1-3 c.f.m.-----	10-mesh-10 μ -----	Efficiency (90-95 percent) depends on solubility and reactivity of gas and absorbent. Particulate material is retained in proportion to porosity of packing and velocity. Requires considerable skill in operation, analytic skill in quantitation (methods: chemical analysis or weight).

Comparison of various devices commonly

Instrument	Type of contaminant	Application	Sample volume
Method: washing or scrubbing—Continued			
Venturi scrubber ²³ -----	Gaseous and particulate.	Stack and general atmospheres.	Large-----
Method: precipitation			
Thermal precipitator ²⁴ -----	Particulate-----	General atmospheres and after cleaning devices.	Small-----
Electrostatic precipitator ^{4 17} -----	do-----	Stack and general atmospheres.	Small, medium, or large.
Method: adsorption			
Tubes or cartridges filled with activated charcoal, silica gel, or alumina. ²⁵	Gaseous-----	Stack and general atmospheres.	Small, medium, or large.
Method: absorption (on solids)			
Tubes or cartridges filled with dry solid chemical. ⁹	Gaseous-----	Stack and general atmospheres.	Small-----
Method: condensation			
Freezing trap ⁹ -----	Gaseous-----	Stack and general atmospheres.	Small-----

¹ Shaw and Owens: The smoke problem of great cities. London, Constable & Co., Ltd., 1925.

² Green: J. Indust. Hyg. 16: 29 (1934).

³ Marks: Mech. Engin. 59: 681 (1937).

⁴ Drinker and Hatch: Industrial dust. New York, McGraw-Hill, 1936.

⁵ Hill: J. Scient. Instr. 14: 296 (1937).

⁶ Briscoe et al.: Tr. Inst. Min. and Met. (June 1937).

⁷ Stern: Combustion 4: 35 (1933).

⁸ The Thermix Corporation, Greenwich, Conn., 1949.

⁹ Jacobs: The analytical chemistry of industrial poisons, hazards, and solvents. Ed. 2. New York, Interscience, 1949.

¹⁰ Brown, Schrenk, and Littlefield: U. S. Bureau of Mines Information Circular 6993, February 1938.

¹¹ Gurney, Williams, and Meigs: J. Indust. Hyg. & Toxicol. 20: 24 (1938).

¹² Bloomfield and Dalla Valle: Pub. Health Bull. No. 217, Washington, D. C., 1935.

used for stack, effluent, and aerosol sampling—Continued

Sampling rate	Particle size range	Remarks
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Method: washing or scrubbing—Continued

30-40 c.f.m.-----	10-mesh-0.2 μ -----	A portable device using the principle of the Pease-Anthony unit. Collecting medium is recirculated. Adapted to both gaseous and particulate material, but the gases should be readily soluble in water or absorbent. 90-95 percent efficient; efficiency on particulates is low. Requires considerable skill in operation, analytic skill in quantitation (methods: chemical analysis or weight).
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Method: precipitation

5-10 ml./min.-----	5-0.2 μ -----	Not adapted to high concentrations or large particles. Excellent for particle sizing including electron micrograph work. 99 percent efficient. Requires considerable skill in operation and quantitation (method: count).
1-3 c.f.m.-----	80-0.2 μ -----	May be used in AC or DC form; DC more practical for field use and requires less voltage. For hot gases arcing becomes a problem. Large particles may not be trapped, but precleaner can be used in series. 99 percent efficient. Requires some skill in operation and quantitation (methods: count, weight, or chemical analysis).

Method: adsorption

1-10 l.p.m.-----	Gases-----	Applicable only to gases which can be adsorbed readily at normal temperatures. Volume of sample collected must be held within adsorptive capacity. Adsorbent may be stripped for chemical or physical analysis. 99 percent efficient. Requires considerable skill in operation and some in quantitation (methods: chemical analysis or weight).
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Methods: absorption (on solids)

1-10 l.p.m.-----	Gases-----	Typical use is to determine acid gases on soda lime or alkali. Moisture interference must be eliminated. 99 percent efficient. Requires some skill in operation and quantitation (method: weight).
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Method: condensation

0.01-1 l.p.m.-----	Gases-----	Applicable to wide variety of materials depending on temperature of freezing bath (dry ice or liquid nitrogen). 99 percent efficient. Requires considerable skill in operation and quantitation (method: chemical analysis).
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¹³ May: J. Scient. Instr. 22: 187 (1945); Sonkin: J. Indust. Hyg. & Toxicol. 28: 269 (1946).

¹⁴ Brady and Touzalin: Indust. & Engin. Chem. 3: 662 (1911).

¹⁵ Katz and Smith: U. S. Bureau of Mines, Report of Investigations 2378, 1922.

¹⁶ Bubar, H. H.: Bagtest sampler. Old Lyme, Conn.

¹⁷ Western Precipitation Corp. Bull. WP50, 1948.

¹⁸ Hardie: Tr. Am. Soc. Mech. Engr. 59: 355 (1937).

¹⁹ Matthews: Analyst 63: 467 (1938).

²⁰ First and Silverman: Arch. Indust. Hyg. & Occup. Med. 7: 1 (1953).

²¹ Mine Safety Appliances Co., Pittsburgh.

²² Silverman: Industrial air sampling and analysis. Chem. & Tox. Bull. No. 1. Industrial Hygiene Foundation, Pittsburgh.

²³ Magill: Stanford Research Inst., 1949; Collins, Seaborne, and Anthony: Paper Trade Journal, January 5, 1948.

²⁴ Watson: Tr. Faraday Soc. 32: 1073 (1936).

²⁵ Cook and Coleman: J. Indust. Hyg. & Toxicol. 18: 194 (1936).

greater importance because of the hydrocarbon problem.

It is also desirable to analyze and correlate information on the general distribution of specific tracer materials, such as pollen and identifiable dusts, in order to determine travel and upper air current transmission under a variety of meteorologic conditions. This may give an insight into the interstate and intercity transmission of pollution.

Recommendations

General particulate or dust-fall measurements on a countrywide basis should be initiated at the earliest opportunity. As a basis for some correlation, it is proposed that weather stations could utilize United States standard rain gauge accumulations which can be filtered, dried, and weighed to give the amount of total undissolved solids. The filtrate can be evaporated and weighed, if desired, to give dissolved solids or salts. The total undissolved solids can be analyzed further; as complete an analysis as can be obtained of the nature of the deposits would be desirable.

General filter samples of airborne particulates should be obtained, and some standardization, within reasonable limits in the light of present knowledge, should be achieved in regard to type of filter media, sampling rate, sample volume, and weighing techniques. Simultaneous collection with particulate fall or settling cans should be made if possible. To obtain any possible relationship between dust-fall and suspended matter, samples of each should be taken simultaneously or over comparable periods.

An evaluation of existing information now available and being collected by various Federal, State, and local groups, such as the Public Health Service, the Atomic Energy Commission, and the various air pollution boards, would be desirable to ascertain the present general levels in air with respect to intercity and interstate migration of pollution and to provide background for appraisal of conditions and their trend.

Whenever possible, correlation with accidental releases of large amounts of foreign materials and severe weather conditions should be obtained. Some effort in this direction has been made already by the Atomic Energy Commission, the Weather Bureau, and the Public Health Service.

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